

CONTENTS

CHAPTER 4

	<u>Para.</u>
BRIEF TECHNICAL DESCRIPTION	
INTRODUCTION	1
CABINET ASSEMBLY	2
Splitter Unit MS444	3
Distribution Amplifier MS442	4
Overload Unit MS443	5
Cabinet V.S.W.R. Unit MS447	6
Meter Panel MS445	7
R.F. POWER MODULE MM42	8
R.F. Amplifier Type MM320	11
Low Level Board	12
High Level Board	13
V.S.W.R. Board	18
Protection Board	21
COMBINING UNIT MS441	24
AUTOMATIC LEVEL CONTROL (a.l.c.)	27
PROTECTION	28
POWER SUPPLIES	
Power Supplies Unit Type MS64	29
Stabilizer Type MS440	30

CHAPTER 5

DETAILED TECHNICAL DESCRIPTION	
INTRODUCTION	1
CABINET ASSEMBLY	2
Control	3
Splitter Unit MS444	4
Distribution Amplifier MS442	7

	<u>CONTENTS</u>	<u>Para.</u>
CHAPTER 5 (continued)		
Overload Unit MS443	10	
Cabinet V.S.W.R. Unit MS447	14	
Meter Panel MS445	15	
R.F. AMPLIFIER MM320		
Interconnection of Sub-Units	18	
Inputs	19	
Outputs	20	
Protection Components	21	
Low Level Board	23	
Automatic Level Control (a.l.c.) Detectors	27	
Muting	30	
High Level Board	32	
V.S.W.R. Board	36	
Protection Board	44	
COMBINING UNIT	47	
Power Combining	48	
Isolation	51	
Design Features	56	
Power Dissipation	57	
AUTOMATIC LEVEL CONTROL (a.l.c.) AND PROTECTION	64	
POWER SUPPLIES		
Power Supplies Unit MS64	71	
Stabilizer Unit MM440	74	

CONTENTSPara.

CHAPTER 6

ROUTINE MAINTENANCE	1
Air Filter	2
Contactor Contacts	3
DISMANTLING AND REASSEMBLY	4
Power Supplies Unit MS64	5
Splitter Unit, Distribution Amplifiers and Overload Unit	8
Circuit Breakers	9
Main Switching Contactor	10
Air Blowers	13
R.F. Power Modules	16
Meter Panel	17
Combining Unit	20
R.F. Power Module MM420	23
High Level Board	24
Method of Changing a P.A. Transistor	25
Access to Stabilizer Heat Sink	26

CHAPTER 7

FAULT LOCATION AND ALIGNMENT PROCEDURE	
INTRODUCTION	1
FAULT LOCATION PROCEDURE	3
Sub-Unit Fault Location	4
FAULT LOCATION - R.F. MODULE MM420	5
R.F. Module Checks - Without R.F. Drive	7
R.F. Module Checks - With R.F. Drive	8
ALIGNMENT PROCEDURES	
Adjustments to R.F. Module MM420	14
Setting-Up the Stabilizer Output Volts	16
Setting-Up the Stabilizer Trip Levels	17
Setting-Up Module Over Voltage - Low Level Trip	18
Setting-Up Module V.S.W.R. Unit	19
Setting-Up Reflected Power Protection Level	20
SETTING-UP AND ADJUSTMENTS OF V.S.W.R. UNIT MS447	22

CONTENTS

Para.

CHAPTER 7 (continued)

SETTING-UP AND ADJUSTMENTS OF COMBINING UNIT MS441

23

CHAPTER 8

LIST OF COMPONENTS

(Not included in Draft Handbook)

LIST OF ILLUSTRATIONS

	<u>Fig. No.</u>
Frontispiece	*
Lay-out of Sub-Units	1.1
Block Diagrams	1.2
Simplified Block Diagrams of Power Supplies	1.3
Block Diagrams of Power Supplies	1.4
Block Diagram of R.F. Amplifier MM320	4.1
Block Diagram of Combining Unit	4.2
Ratio: Approx. O/P/Inoperative Modules	5.1
 Cct: Splitter Unit	1
Layout: Splitter Unit	2 *
 Cct: Distribution Amplifier	3
Layout: Distribution Amplifier	4 *
 Cct: Overload Unit	5
Layout: Overload Unit	6 *
 Cct: Cabinet V.S.W.R. Unit	7
Layout: Cabinet V.S.W.R. Unit	8 *
 Cct: Meter Panel	9
Layout: Meter Panel	10 *
 Cct: V.S.W.R. Warning P.C.B.	11
Layout: V.S.W.R. Warning P.C.B.	12 *
 Cct: Low Level P.C.B.	13
Layout: Low Level P.C.B.	14 *
 Cct: High Level P.C.B.	15
Layout: High Level P.C.B.	16 *

LIST OF ILLUSTRATIONS (continued)

	<u>Fig. No.</u>
Cct: V.S.W.R. P.C.B.	17
Layout: V.S.W.R. P.C.B.	1B *
Cct: Protection P.C.B.	19
Layout: Protection P.C.B.	20 *
Cct: Interconnections R.F. Module MM320	21
Layout: R.F. Module	22 *
Cct: Combining Unit	23
Layout: Combining Unit	24 *
Cct: Power Supply MS64	25
Layout: Power Supply MS64	26 *
Cct: Stabilizer MS440	27
Layout: Stabilizer MS440	28 *
Cct: Overall Interconnecting Diagram	29
Layout: Cabinet Connectors	30 *

* Not Included in Draft Handbook.

TECHNICAL SPECIFICATION

Frequency Range	1.6 to 30.0MHz
Power Output	1KW ± 1dB p.e.p. and C.W.
Output Impedence	50Ω (will operate at full power into 3:1 V.S.W.R. when operating with MA1004 Feeder Matching Unit.)
Intermodulation Products	35dB below 1 tone 1.6 to 10MHz, 25dB below 1 tone 10.0 to 30MHz.
Harmonic Radiation	Better than -43dB below p.e.p. when operating with MA1004 or MA1034 filter units.
Wideband Noise	125dB in 3KHz bandwidth - with exciter muted.
Input Level	25 - 100mW.
Input Impedence	50Ω
Supply	210-250V single phase 47-60Hz. Consumption 5kVA maximum.

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The TA1810 is an all solid-state wideband linear amplifier which operates over the frequency range 1.6MHz to 30MHz. The output power (1kW total) is obtained by combining the 125W outputs of eight identical plug-in modules in a passive combining network.
2. The amplifier, complete with power supplies etc, is mounted in a floor standing cabinet the top section of which contains space for fitting associated drive equipments and filter feeder matching units (para.5). The amplifier operates from a 200/250V single phase AC supply, and internal regulation (up to $\pm 6\%$) is provided, as are all necessary cooling and air filtering facilities.
3. Installation is extremely simple (see Chap. 3). For fixed station operation it is not essential to fix the cabinet directly to the floor, since it can be free standing if required, (see CAUTION on page 3-1) Alternatively the cabinet can be bolted permanently to the floor. Electrical connections i.e. audio, keying and AC supply are made to terminals in the bottom rear of the cabinet, the RF output connector is situated at the top rear.

ASSOCIATED EQUIPMENTS

4. The TA.1810 amplifier is designed to operate primarily with the Racal MA.1720 (Synthesised, or MA.7917 (Channelised) Transmitter Drive Units. It can, however, be used in conjunction with any HF exciter with a nominal 100mW output over the required frequency range.

5. Connection to an external antenna should be made via one of two alternative units, dependant upon the type of antenna to be used, viz.
 - (i) For operation into a wideband antenna, cut dipole, or any other antenna which will normally present a V.S.W.R. better than 3:1 at the operating frequency, the Racal Feeder Matching Unit Type MA.1004 is recommended. This is a fast-acting automatically-tuned unit which ensures maximum power transfer into the antenna at all frequencies, and at the same time provides a high degree of attenuation to harmonic frequencies.
 - (ii) When operating into a whip or long wire antenna with an associated aerial tuning unit, the Racal Filter Switching Unit (Type MA.1034) is required. This unit is a simpler device than the MA.1004, and provides harmonic attenuation; power matching is provided by the external A.T.U.
6. The TA.1810 cabinet assembly is designed to include, as required, any combination of exciter (MA.1720 or MA.7917) and output filtering/matching unit (MA.1034 or MA.1004) thereby providing an overall self-contained, fully automatic, solid state H.F. transmitter.

COMPOSITION OF THE TA.1810 AMPLIFIER

Fig. 1-1

7. This section lists the units, modules and printed-circuit (p.c.) boards which form the TA.1810 linear amplifier. Detailed technical descriptions are given in Chap. 5.

Prefix Codes

8. Prefix codes are given to each unit or module and to each board in a unit or module as listed below. As an example, the complete reference for resistor R1 of board A in sub-unit No. 5 is 5AR1. Prefix codes are shown encircled on illustrations.

PREFIX CODES

<u>Prefix Code</u>	<u>Unit, Module or P.C. Board</u>	<u>Type No.</u>	<u>Quantity Used</u>	<u>Circuit Diagram Fig. No.</u>
1	Cabinet Assembly	TA.1810	1	30
	Containing			
1A	Power Supply Module	MS.64		
1B	" " "	"		1 each
1C	" " "	"		Four identical
1D	" " "	"		Modules. 25
None	R.F. Power Module	MM.420	8	
	Consisting of			
4	Stabilizer Module	MM.440	8 (total)	27
	. Containing			
4A	P.C. Board	PS.313	8(total)	
5	R.F. Amplifier Module	MM.320	8(total)	
	Containing			
5A	Low Level Board	PS.314	8(total)	13
5B	High Level Board	PS.315	8(total)	15
5C	Protection Board	PS.251	8(total)	
5D	VSAR Board	PS.316	8(total)	
6	Combining Unit	MS.441	1	23
	Containing			
6A	P.C. Board A	PS.252	1	
6B	P.C. Board B	PS.252	1	

<u>Prefix Codes</u>	<u>Unit, Module or P.C. Board</u>	<u>Type No.</u>	<u>Quantity Used</u>	<u>Circuit Diagram Fig. No.</u>
7	Splitter Unit	MS.444	1	1
	Containing			
7	P.C. Board	PS.318	1	
8	Distribution Amplifier	MS.442	2	3
	Containing			
8	P.C. Board	PS.319	2(total)	
9	Overload Unit	MS.443	1	5
	Containing			
9	P.C. Board	PS.322	1	
10	Cabinet VSWR Unit	MS.447	1	7
	Containing			
10	P.C. Board	PS.317	1	
11	Meter Panel Assembly	MS.445	1	9
	Containing			
11	VSWR Warning P.C. Board	PS.446	1	11

THE R. F. CIRCUITS

Fig. 1.2

9. A block schematic showing the RF path and the RF levels within the RF circuits is given as Fig.1.2 These circuits are now described in more detail. The RF levels appearing at each stage are also shown. The RF input from the associated transmitter drive unit is fed into the splitter unit which provides a separate output to each distribution amplifier. The distribution amplifiers each provide four buffered outputs at 50Ω with a nominal gain of 3dB from the input to each output. The four outputs each amplifier via 50Ω coaxial lines to the inputs of the MM.420 modules. The 125W output from each RF module is fed, via 50Ω coaxial lines, to inputs on the combining units MS.441.

10. The module outputs are combined two at a time in hybrid stages. The first four hybrid stages provide four 250W outputs which are combined in two further hybrid stages to produce the two 500W outputs. The two 500W outputs are available separately at 50Ω impedance, at a patch panel. During normal operation both outputs are connected to the final hybrid transformer to produce a combined output of 1kW.

11. The gain characteristics of each module are maintained at similar values, via automatic level control circuits. In addition electrical path lengths, including coaxial cable lengths, are similar for each circuit. These provisions ensure that the phase and amplitude characteristics of each path are similar, thus allowing the combining unit to function at optimum efficiency.

12. The complete system from input to output is wideband, therefore no tuning or moving parts are involved.

13. The output from the combining unit is normally fed via an MA.1004 or MA.1034 unit (see para.5) which, in turn, feeds the V.S.W.R. unit Type MS.447. The V.S.W.R. unit monitors the forward and reflected output power from the amplifier and provides visual indication (and an external warning voltage) should a pre-determined V.S.W.R. be exceeded.

14. The automatic level control circuits (para. 11) also provide protection by automatically reducing power if a mismatch impedance occurs at the module outputs.

15. The overload unit Type MS.443 (not shown in fig.) automatically monitors the operational state of the amplifier and provides an external signal if unbalanced RF inputs are fed to the combining unit, or if any MS64 power supply unit fails (See chapter for a detailed description).

POWER SUPPLY DISTRIBUTION

Figs . 1.3 and 1.

16. Each 500W amplifier is provided with its own power supply which can be independently switched. Each power supply consists of two identical DC power supply units Type MS64 whose outputs are paralleled to provide DC supplies to each bank of four RF modules. Associated with each RF module is a Stabilizer Module MM.440 which farms part of the Type MM240 Amplifier. Each MM440 module provides a stabilized DC output to each RF module under varying AC conditions and includes a fast current trip circuit to protect the RF circuits if an overload occurs. The DC voltage and the current taken by each module can be monitored at the amplifier meter panel.

OPERATIONAL FEATURES

Active Standby Philosophy

17. The 1kW amplifier TA.1810 consists basically of two 500W amplifiers, each comprising four 125W RF modules. Each 500W amplifier is mechanically and electrically independent of the other, except for the final hybrid stage of the combining unit, where the two 500W outputs are combined to give 1kW. The final hybrid stage can be bypassed by external patching, allowing one amplifier to continue to function and provide 500W output, regardless of condition, of the second 500W amplifier.

18. The operational flexibility of the two 500W amplifiers is increased by using eight independent RF modules each providing 125W output. As the outputs of the modules are combined, (not paralleled) they are isolated from each other electrically. Therefore one operational module is not affected by a defective module even if the defect is a short-circuit, open circuit or any other fault condition. In addition, a defective module can be unplugged and replaced while the remainder of the modules continue to operate. The only effect on transmission due to a defective module will be a small reduction in output power (of the order of 1.5dB).

19. This extremely important feature together with the ability to transmit temporarily with only one 500W amplifier in use (para. 17) ensures an overall equipment reliability very much greater than that obtained using conventional transmitters, giving a 'lost transmission time' due to faults that is extremely small.

20. It should be noted that when a failure of one 500W amplifier occurs the radiated power is reduced from 1KW to 250W until the output connector is transferred (patched) to the still functioning 500W outlet. Until patching is carried out 250W is dissipated internally in the combiner (which is continuously rated) allowing only 250W to appear at the output. Patching for 500W output can be carried out at a suitable break in transmission; approximately 30 seconds is required for this operation.

Operating Indicators on Modules

21. Each module can be switched off separately at its own front panel. The operating state of each module is indicated by two front-panel lamps. The illumination of the green lamp shows the presence of the D.C. supply; the white lamp illuminates when the module is providing an RF output. A faulty or weak module is indicated by a lower level of illumination when compared with the remainder of the indicator lamps.

Metering & Monitoring

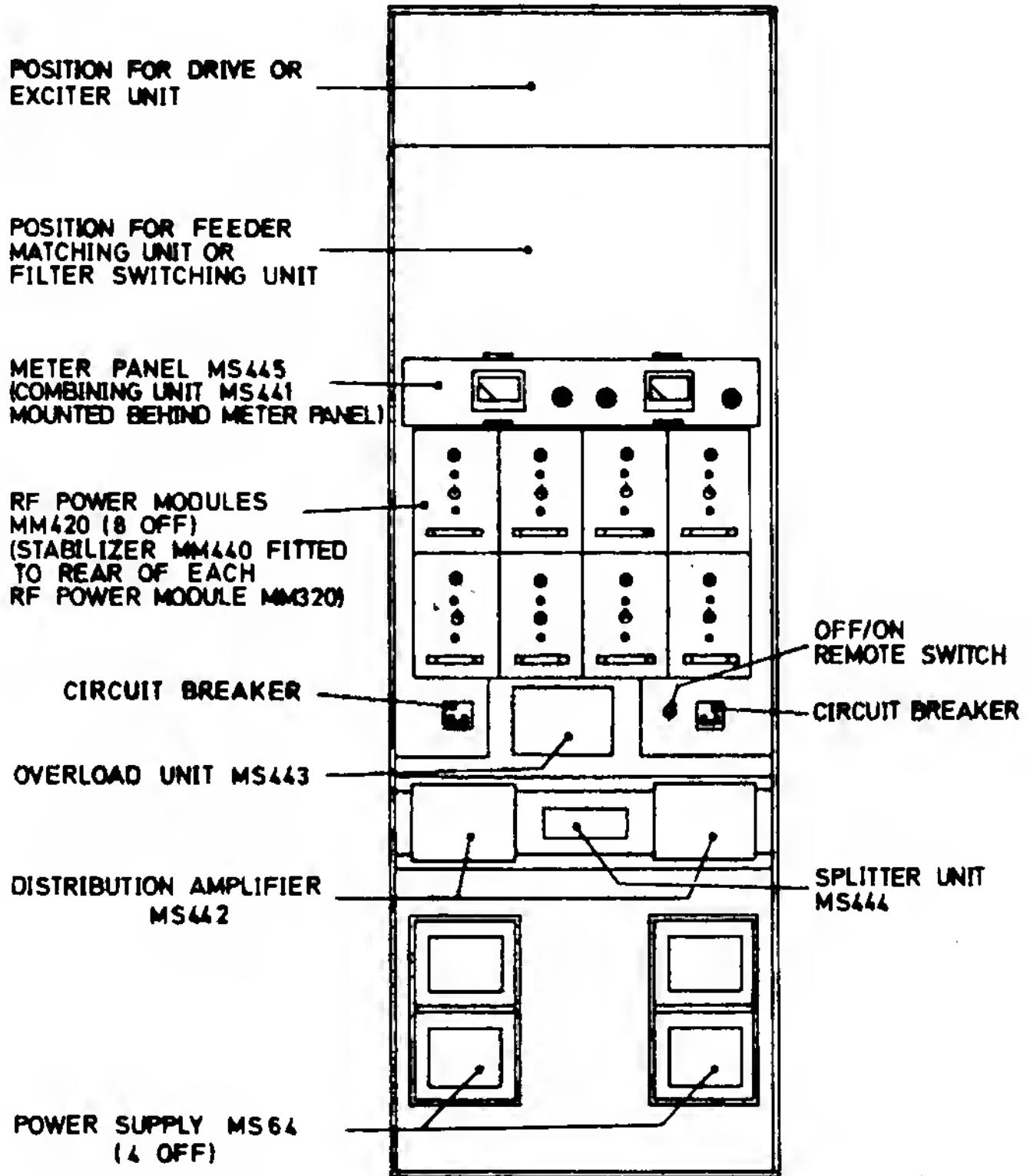
22. The Metering panel (MS445) allows metering of the 30V DC supply voltage and current to each module. In addition the input RF power level and the forward and reflected output power levels are indicated. Front panel monitoring is provided for all module outputs, each 500W output and the 1KW output, via 50Ω BNC connectors.

COOLING

23. Forced air cooling is built into the amplifier cabinet. Two similar blowers are fitted at the bottom of the cabinet for cooling the RF modules, a third is located at the top rear of the cabinet and provides general cooling for the units fitted at the top of the cabinet. The total air flow from each blower fitted to the base of the cabinet is approximately 220cfm at 1.3W.G.

24. When the standard version of the cabinet is used air is taken in from the front via the filter panel which covers the power supply units at the bottom of the cabinet, and is exhausted at the rear of the cabinet. When a ducted system (to special order) is required the air filter is fitted at the rear of the cabinet and inlet and outlet ducting are bolted to the rear cabinet skin.

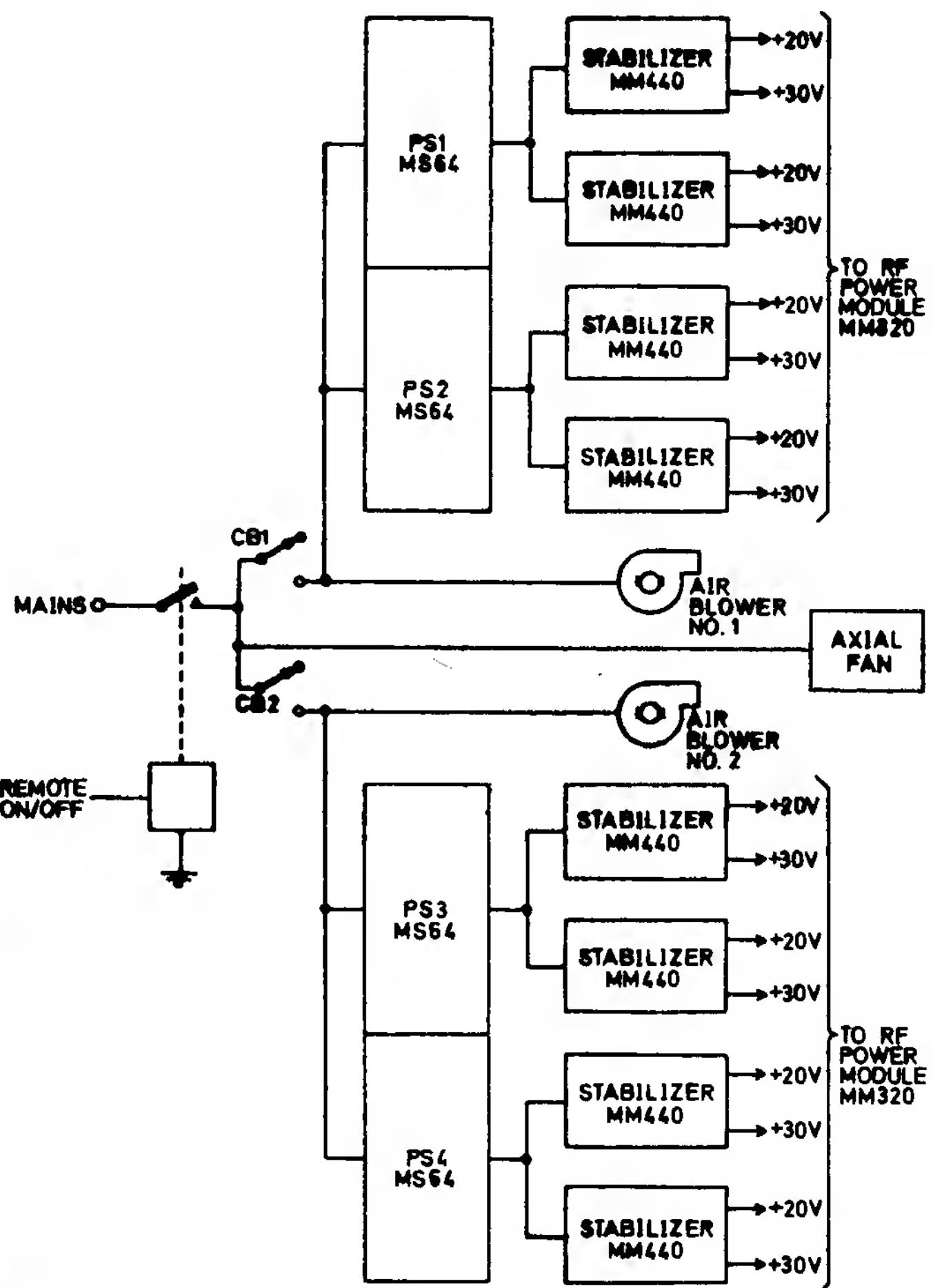
25. The air flow system is not interlocked with the electrical system since all RF modules are individually protected against overheating. The RF modules will operate for a considerable period of time (dependent on ambient temperature) with both blowers inoperative. This means that the equipment can be operated satisfactorily for several minutes with a module removed and a consequent loss of air through the gap created.



WOH3037

TA.1810 : Location of Sub-Units

Fig. 1.1



TA.1810 Simplified Block Schematic:
Power Supply Distribution

WOH3037

Fig. 1-3

CHAPTER 2

SETTING - UP AND OPERATING INSTRUCTIONS

INTRODUCTION

1. It is assumed that the installation procedure described in the previous chapter has been carried out, i.e. all units are mounted within the cabinet assembly, and all external wiring connections made in accordance with the appropriate system handbook. Initially, the Setting-Up Procedure given in para. 3 to 5 should be carried out prior to the Operating Procedure.

OPERATING PROCEDURE

2. Switching on is achieved as follows:-

- (i) Set the amplifier central switch to ON for 'local' operation, or to REMOTE.
NOTE: When REMOTE is selected the amplifier is switched on from an external source by a 12V line. Switching is normally carried out from the MA.1720 exciter when this unit is fitted.
 - (ii) Check that the blower at the top of the cabinet operates when ON is selected.
 - (iii) Set the two front panel circuit breakers on the TA.1810 to ON. This immediately energizes the blowers and switches on all the supplies to the overall amplifier. In this condition the individual RF modules are not muted. To mute them it is necessary to apply external earth connection to T88 Pin 7.
 - (iv) Switch ON all the RF modules via their respective front panel switches, and note that all green lights are illuminated.
 - (v) Check that the 20V and 30V supplies are present at all modules as indicated on the appropriate meter. Monitor the individual module currents on the switched meter, and ensure they all indicate approximately equal values.

SETTING-UP PROCEDURE

3. With the output connector terminated in a 50Ω dummy load feed in an appropriate CW drive signal within the range 1.6 to 30MHz. Note that the clear lights on all modules illuminate at equal brightness
4. Monitor module currents at the front panel meter and ensure that they all indicate approximately 12A and that in no case is 15 amps exceeded. Currents will be lower at the LF end of the band, and highest at midband, but any one frequency settings, individual module currents should be similar.
5. Switch-off, disconnect dummy load and connect antenna.

CHAPTER 3

INSTALLATION

GENERAL

1. Installation of the TA.1800 amplifier is extremely simple, requiring only the connection of a suitable single phase mains supply, an aerial feeder and audio/keying inputs.
2. The equipment is normally shipped with RF modules in position, but with the power supplies packed separately. Fitting of these power units in the cabinet is carried out after all necessary mechanical fixing and electrical connections have been made.

FLOOR MOUNTING

3. The amplifier is provided with floor standing fitments and need not be permanently fixed to the floor. If a permanent fixing is intended then the feet provided should be removed from the base and then replaced with screws into the floor.

CAUTION: When the cabinet is not fixed to the floor only one power unit should be withdrawn at any one time to avoid the danger of the cabinet toppling.

ELECTRICAL CONNECTIONS

Mains Supply

4. A single phase voltage supply of approximately 250 mps is required. Line, neutral and earth connections are made in the rear of the cabinet at the bottom (TB1 Pins 1, 2 and 3 respectively.) Each MS64 Power supply has an individual mains selector plug. This should be set to the voltage appropriate to the incoming mains supply.

Antenna Connection

5. This is made to the output RF (Type C) connector at the top rear of the cabinet. UR67 (50Ω) cable is recommended.

AUDIO/KEYING INPUTS

6. These connections should be made to TB16 at the bottom of the cabinet in accordance with the following table.

NOTE: For further information refer to the associated System Handbook.

TABLE OF AUDIO/KEYING CONNECTIONS

TB16

Pin	1)	
	2	}	Audio 1
	3		Screen
	4)	
	5	}	Audio 2
	6		Screen
	7)	Keying
	8	}	Earth
	9)	RTTY
	10	}	Earth
	11		---
	12		

MAIN EARTH

7. An earth strap should be connected between the earth point in the base of the cabinet and the main station earthing system.

MISCELLANEOUS EXTERNAL CONNECTIONS

8. When operating with associated units such as MA.1720 exciter, MA.1004 feeder matching unit etc. other connections will have to be made to the relevant terminals of the TA.1810.

Full details of such interconnections are given in the appropriate section of the relevant system handbook.

CHAPTER 4

BRIEF TECHNICAL DESCRIPTION

INTRODUCTION

1. The following paragraphs briefly describe the function of the units and sub-units which constitute the TA 1810 Linear Amplifier; detailed technical descriptions are given in Chapter 5.

CABINET ASSEMBLY

2. As detailed in Chapter 1, the sub-assemblies contained in the TA 1810 cabinet are the Splitter Unit, Distribution Amplifiers, Overload Unit, Cabinet V.S.W.R. Unit and Meter Panel.

Splitter Unit MS 444

3. The splitter Unit is a passive network providing two separate outputs of equal amplitude and phase to the Distribution Amplifiers, the unit also provides the metering facility for the RF input level.

Distribution Amplifier MS 442

4. Each Distribution Amplifier provides four separate and isolated RF outputs to a bank of four RF Power Modules. Each unit contains four buffer amplifiers each with an approximate gain of 6dB. - and 3dB? chapter page 9.

Overload Unit MS 443

5. The overload Unit provides a reduced power warning signal in the event of failure of a power supply or an RF Power Module. The unit also provides a 'fault' signal if either the main contactor fails or a 'fault signal' is received from an associated unit, such as the MA 1004 Feeder Matching Unit.

Cabinet V.S.W.R. Unit MS 447

6. The Cabinet V.S.W.R. Unit monitors the forward and reflected powers on the RF output feeder and provides the respective d.c. outputs to the Meter Panel MS 445.

Meter Panel MS 445

7. The Meter Panel contains two meters and associated switches to provide metering of the voltages applied to and the current drawn by each RF Power Module, RF input power and the Forward and Reflected RF output power. The Meter Panel also contains V.S.W.R. Warning Board which comprises a trip circuit operated by the V.S.W.R. Unit reflected power line. The trip circuit can be used to operate a fault line to a suitable external circuit.

RF POWER MODULE MM 420

8. The RF Power Module Type MM 420 is an all solid-state wideband linear amplifier capable of delivering at least 125 Watts over the frequency range 1.6 MHz to 30 MHz.

9. The complete module consists of a basic RF Amplifier Type MM320 and a power stabiliser unit Type MM440. The two units consisting of printed circuit boards mounted on finned castings are bolted together in line to form a complete plug-in unit. When required they can be readily separated, for example, when replacing a faulty stabiliser unit.

10. Eight complete modules (MM 420) are used in the TA 1810 Linear Amplifier and each module plugs directly into the TA 1810 cabinet.

RF Amplifier Type MM 320

11. The RF Amplifier Type MM 320 consists of a Low Level Board and High Level Board which make up the basic RF amplifier together with two associated printed circuit boards, namely a V.S.W.R. Board and a Protection Board. A block diagram and an interconnection of the amplifier assembly is shown in Fig. 4-1 whilst the interconnection and physical location of the sub-units are shown in Figs. 21 and 22 respectively.

Low Level Board

12. This board amplifies the input R.F. signal of 10mW from the Distribution Amplifier up to approximately 2W. In addition it provides a variable gain stage which is used as the automatic level control circuit to maintain the output R.F. level of the High Level Board constant and to reduce the output to a safe level when a load mismatch occurs.

13. The R.F. input to the Low Level Board is fed first to the Automatic Level Control (a.l.c.) stage consisting basically of two transistors operating in class A push-pull. The gain is varied by causing two other transistors each in parallel with the class A transistors to partially conduct, thereby tending to shunt part of the R.F. drive - the greater degree of conduction, the lower the effective gain of the class A transistor stages.

14. Following the a.l.c. stage are two class A amplifier stages. The first stage comprises two transistors operating in grounded base and connected in a push-pull configuration. The second stage is similar to the first but employs four transistors connected in a parallel/push-pull configuration and transformer coupled to the output.

High Level Board

15. This board contains two stages of R.F. amplification. The drive stage consists of two power transistors (2N5102) operating in class B push-pull with grounded base. This stage is transformer coupled to the final P.A. stage which comprises 8 power transistors (also 2N5102's) which are connected in a parallel push-pull arrangement and operated in a common emitter mode. Negative feedback is applied over the P.A. stage to ensure a flat response over the frequency range.

16. All components associated with the R.F. amplifier, with the exception of the transistors, are mounted on the High Level Board. The transistors themselves are stud-mounted on the main casting to ensure maximum heat dissipation. Replacement of a transistor can be effected without removing the High Level Board - Refer Chapter 10.

17. Also included on the High Level Board are diodes monitoring the power transistors collector R.F. voltage. If this becomes too large, the diodes conduct and operate the a.l.c. stage to reduce the drive level (refer to para. 13).

V.S.W.R. Board

18. The Voltage Standing Wave Ratio Board monitors the forward and reflected output power of the High Level Board before it is fed to the R.F. output connector of MM 420.

19. The forward power detector is fed back to the a.l.c. stage on the Low Level Board to control the output level under normally matched conditions (i.e. 50Ω). The actual forward output level is set by a potentiometer.
20. Under mismatched conditions, the resultant output from the reflected power detector is also fed back to the a.l.c. stage via a fast response network, to reduce the output level appropriate to the degree of mismatch. The level at which the reflected power takes over from normal a.l.c. control is adjustable via a second potentiometer.

WARNING

THESE CONTROLS SHOULD ONLY BE ADJUSTED WHEN SETTING UP THE MODULE UNDER CONTROLLED CONDITIONS. IT SHOULD NOT BE ADJUSTED WHEN THE MODULE IS INSTALLED IN THE TA. 1810, SINCE THE PROTECTION AFFORDED TO THE OUTPUT TRANSISTORS WOULD BE REDUCED WITH THE CONSEQUENT RISK OF TRANSISTOR FAILURE.

Protection Board

21. The Protection Board is designed to provide protection for the R.F. amplifier against d.c. fault conditions. Depending on the actual fault, it operates in one of two ways.
22. Firstly if a short circuit should occur on the Stabiliser Unit (MS 440) this would apply approximately 40V to the Amplifier H.T. rail, overstressing the R.F. transistors. To prevent this a power zener diode is included which in the event of such a fault, conducts and operates a fuse thereby open circuiting the positive supply.
23. Secondly if the collector currents of the R.F. output transistors exceed a prescribed maximum (approximately 7 Amp for each group four transistors) a fast acting d.c. overload signal is applied to the a.l.c. stage on Low Level Board, to ensure this current level is not exceeded.

Note: If reducing the R.F. drive does not control the transistor currents then a d.c. overload trip in the stabiliser unit will operate.

COMBINING UNIT MS 441

24. The Combining Unit is a completely passive unit containing only a series of hybrid combining transformers, impedance transformers and ballast load resistors.

25. The function of the unit is to accept the output of each R.F. Power Module and to combine their output powers into a common output line whilst providing RF isolation between any one module and the others.

26. As shown on the block schematic of the Unit Fig. 4.2 the eight RF inputs from the RF Power Modules are fed into hybrid transformers in pairs and the first four hybrid stages produce four 250 W outputs. These 250W outputs are again combined in pairs to produce two 500W outputs which are combined in a final hybrid to produce the 1kW output. The final hybrid may be by-passed if it is required to operate an 500 W output. (Chap. 1 para 17 refers).

AUTOMATIC LEVEL CONTROL (a.l.c.)

27. Automatic Level Control (a.l.c.) is applied to the Low Level Board of each RF Power Module. Under certain operating conditions the a.l.c. will control the RF output level of each module to protect the transistorized RF circuitry.

PROTECTION

28. Each RF Power Module is protected against overheating and short circuits in the stabiliser Type MM 440, a latching trip circuit is provided for each stabiliser Unit and each power unit is provided with a.c. supply overload protection.

POWER SUPPLIES

Power Supplies Unit Type MS 64

29. The main d.c. power supply for the TA 1810 is provided by four standard d.c. power supplies Type MS 64 each providing smooth unregulated d.c. outputs from single phase a.c. mains input.

Stabiliser Type MM 440

30. The stabiliser Type MM 440 provides stabilised +30V d.c. and +20V d.c. supplies to each RF Amplifier Type MM 320. In addition each stabiliser provides current metering facilities for the -30V d.c. and +20V d.c. supplies.

Block Diagram: RF Amplifier MM320

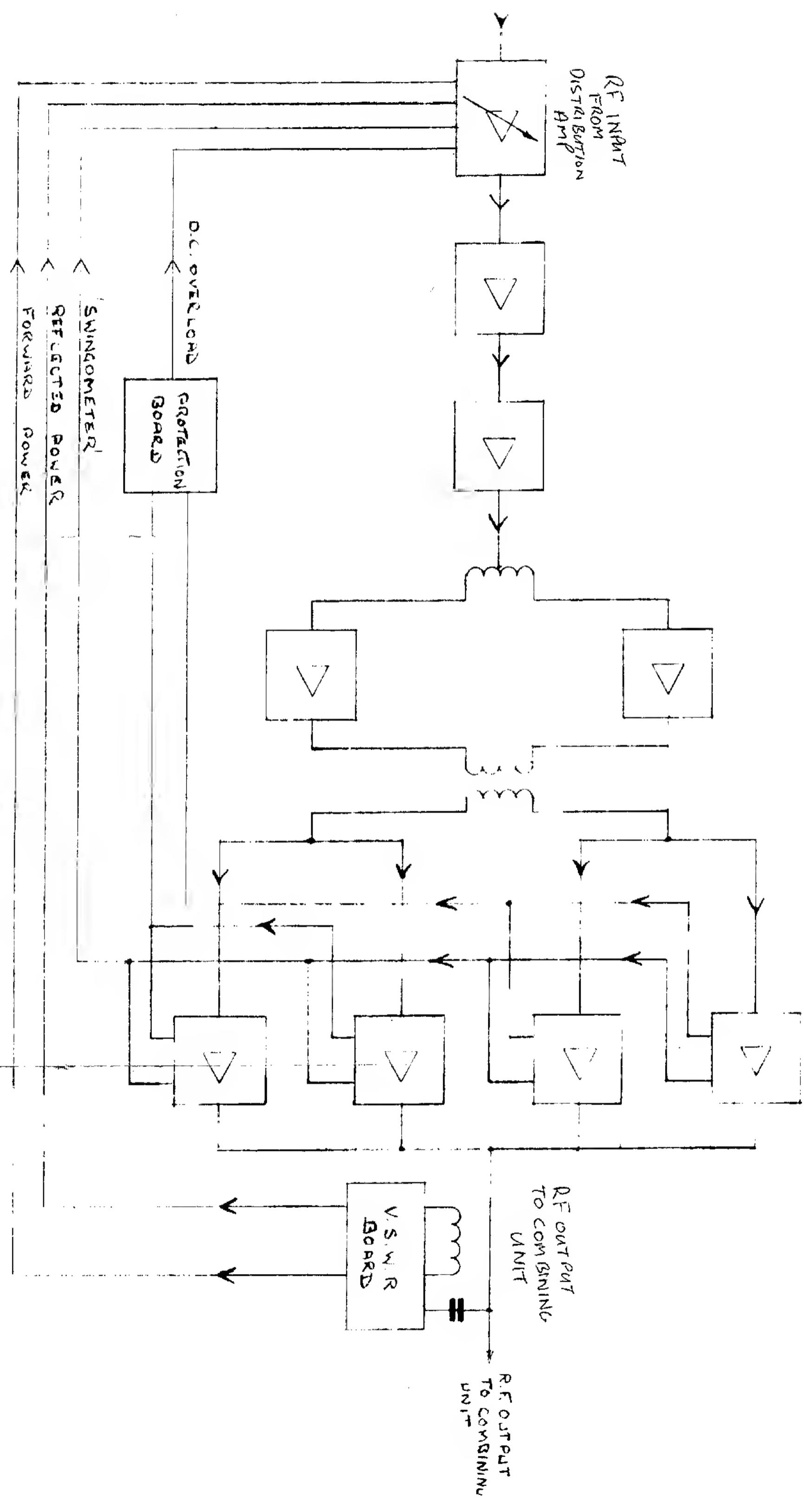
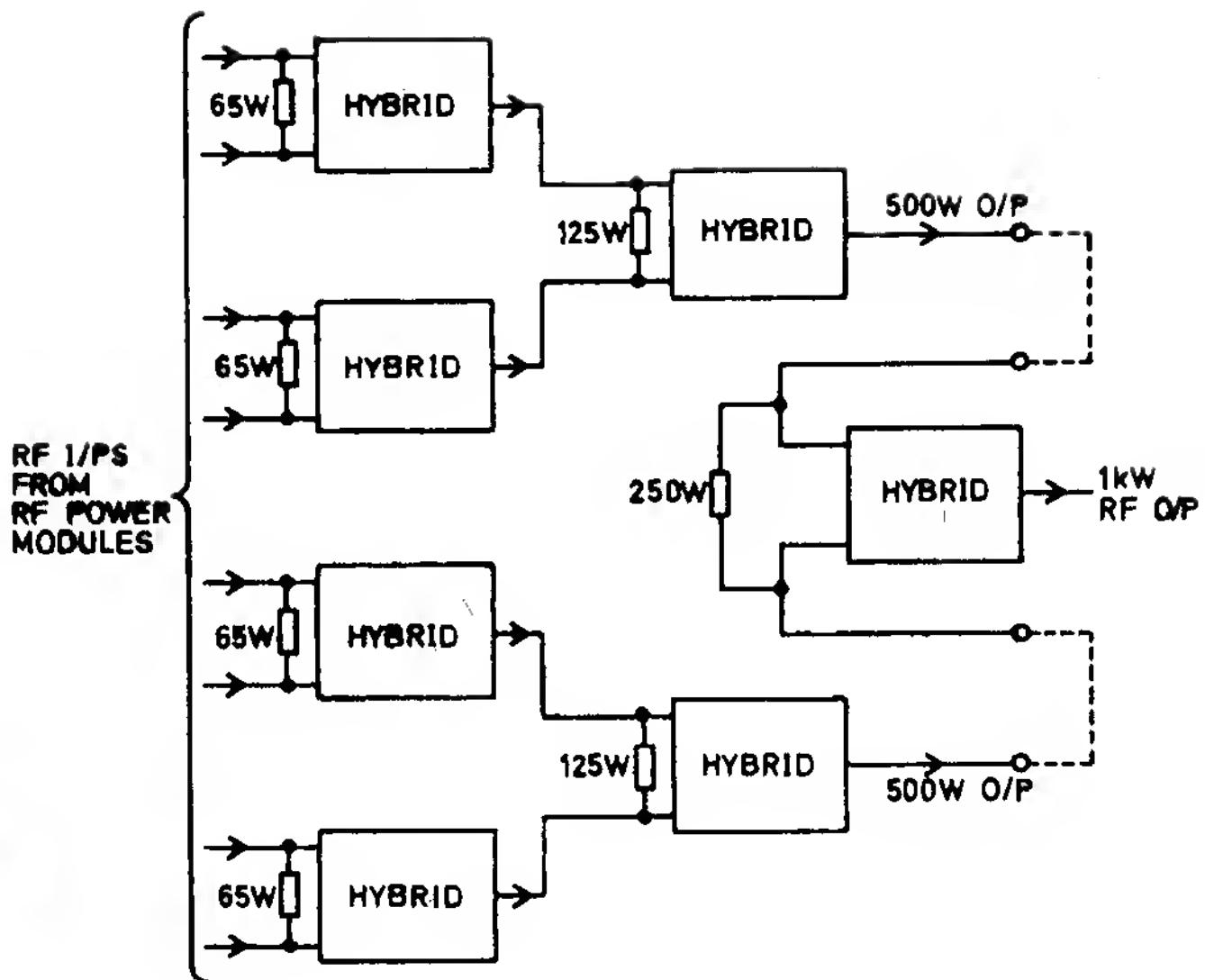


Fig. A.1



WOH3037

Block Diagram: Combining Unit

Fig. 4-2

CHAPTER 5

DETAILED TECHNICAL DESCRIPTION

INTRODUCTION

1. The circuit descriptions detailed in the following paragraphs should be read in conjunction with the appropriate circuit diagram.

CABINET ASSEMBLY

2. As outlined in Chapter 1, the TA 1810 cabinet assembly comprises the Splitter Unit, Distribution Amplifiers, Overload Unit, Cabinet V.S.W.R. Unit and Meter Panel in addition to items such as switching contractors, circuit breakers, blowers, coaxial line switching relays and miscellaneous interconnecting cableforms. The overall interconnection diagram is shown in Fig. 29.

Control

3. Switching on of the overall cabinet assembly can be accomplished from the local position (i.e. power supply front panel) or from a remote position. This requires the internal 12V starting relay to be energized from the remote point. Selection of OFF, LOCAL or REMOTE CONTROL is made from the front of the cabinet assembly. Each 500W power supply and associated blower can be switched off independently by operation of the relevant circuit breaker.

Splitter Unit MS 444

Fig. 1

4. The R.F. input from the drive unit is fed in at SK1. It is then linked to one of three pins pins 12, 13, and 14 on PS 318 giving a choice of 0dB, 3dB or 6dB attenuation to accommodate different input levels from the drive source. The RF signal is then passively split two ways, each via a 50Ω resistor, to give two separate outputs on PL2 and PL3.

5. The output of the attenuator stage, at the junction of R9 and R10 is detected and a D.C. output fed from an emitter follower (TR1) to provide meter indication of the R.F. level. Calibration of this is effected by R12.

6. Two 30V line inputs from the two 500W power supplies are dioded together to provide an output on PL1 Pins 2 and 9 for connection to the Overload Unit to enable the unit to continue operating if either supply is removed.

Distribution Amplifier MS 442

Fig. 3

7. Each Distribution Amplifier provides approximately 6dB of gain from the input to each output. The input from the Splitter Unit is fed into SK5 which is connected to 4 separate auto transformers T2, T4, T6 and T7 paralleled together. C10 ensures a flat frequency response. The centre tap of each transformer is fed via a resistor into the emitter of a grounded base transistor biased by a DC voltage derived from a resistive network R1 and R2 across the 30V supply rail.

8. The collectors of each transistor are transformer - coupled and isolated R.F. outputs at SK1, SK2, SK3 and SK4. The diodes and zener diodes across each output transformer ensure that the positive collector voltage swing never exceeds the safe transistor rating.

9. Four dioded 30V inputs on PL1, Pin 1, 2, 3 and 4 fed from the four MS 64 power supply units ensure that the Distribution Amplifier can still operate as long as just one MS 64 remains on. The 30V output on PL1 connects to the Overload Unit via the Splitter Unit.

Overload Unit MS 443

Fig. 5

10. The function of this unit is to provide a 'reduced power' warning signal in the event of failure of a power supply or an R.F. module. It also provides a 'fault' signal if either the main contactor fails or a 'fault' signal is received from an associated unit, such as the MA 1004 Feeder Matching Unit.

11. The D.C. outputs of all four MS 64 units are monitored and fed to PL1, pins 8, 9, 11 and 12 of the Overload Unit. Each input is fed via noise immunity circuits (e.g. C1, D1, R3, R7 and TR1). These circuits ensure that transient noise spikes will not cause the circuit to give a false indication, and that they will only respond to genuine input signals. The noise immunity transistors are connected in series so that when any are switched due to having no input, TR5 will be switched on.

12. If an R.F. imbalance input signal is preset at PL1 Pin 4 then TR7 is switched off and C9 charges through R25. TR11 and TR12 form a bistable latching circuit which, in the normal state, has TR12 switched on and TR11 off. However, as C9 charges up, after a warning signal is received, TR11 is turned on, and after a delay, the circuit switches over to the other latched state with TR11 conducting and TR12 switched off. In this condition TR13 is switched off and 12V (via R35 - 4.7 KΩ) appears at the output, PL1 Pin 10, in the alarm condition. The normal condition gives a OV output.

13. This latched condition is maintained even if the fault signals are removed. It is set by an unlatching signal applied to PL1 Pin from the external coarse - tune initiate/reset' line. This is normally derived from the MA 1720 drive unit. Diodes D8 and D9 and C11 provide noise immunity.

V.S.W.R. Unit type MS 447

Fig. 7

14. This unit monitors the forward and reflected powers on the R.F. output feeder and provides the respective d.c outputs to the Meter Panel MS 445. The design is that of a conventional reflectometer and is identical in principle to the R.F. Module V.S.W.R. unit described in paras. 36 to 43. It is balanced by adjusting C3 for an indicated null on reflected power when the feeder is terminated in 50Ω .

Meter panel type MS 445

Fig. 9

15. This unit contains two meters, ME1, which is switched and meters the +30V, +20V supplies to currents drawn by each of the eight R.F. modules and ME2 which is also switched to monitor the input power (fed from the Splitter Unit), and the forward and reflected powers fed from the V.S.W.R. Unit.

16. Also included is a V.S.W.R. Warning P.C.B. (Fig. 11) which contains a trip circuit operating from the V.S.W.R. Unit reflected power line. The trip circuit comprises a long-tailed pair, TR2 and TR3, driven from TR1. TR4 provides the output which can be used to operate a 'fault' line to the MA 1720 or any other suitable external circuit. The trip level is normally set to operate at 3.1 V.S.W.R. but can be changed by altering R12.

17. Switch S1 on the V.S.W.R. Warning Board is set to NORMAL during traffic condition. The CAL position is used during setting-up procedure.

RF AMPLIFIER TYPE MM 320

Interconnection of Sub-Units

Fig. 21

18. The overall interconnection of the sub-units making up the RF Amplifier Assembly are shown on Fig. 21

Inputs

19. The power supply inputs are +20V and +30V DC on TS1 Pins 3 and 2 respectively.

These are connected directly to the associated Stabiliser Unit Type MM 440. The only other connection is the external muting line on TS1 Pin 4. This applies a OV signal to the Low Level Board which operates the relevant switching transistors thereby cutting off the RF output. The R.F. input from the Distribution Amplifier is at PL1.

Outputs

20. The R.F. Output appears at PL2. It is fed from two outputs on the High Level Board, which are connected together prior to T1. The latter is a monitoring transformer, feeding LP2 and an external R.F. monitor socket. T2 is the reflectometer toroid for the V.S.W.R. unit and C3 is the associated capacitive probe.

Protection Components

Fig. 21

21. Other miscellaneous components shown on the Interconnection Diagram Fig are associated with module protection.

22. SCR1 is fired under a fault condition from the Protection Board, thereby short-circuiting the +30V line and operating FS1, C1, L1 and C2 are RF decoupling components.

The L1 is the thermostat on the Assembly heat sink which open circuits the +20V supply rail if the safe working temperature (approx. 85°C) is exceeded.

Low Level Board PS 314

Fig. 13

23. The R.F. input is connected to pins 4 and 5 on the printed circuit board. It is transformer coupled via T4 to provide a balanced push-pull signal on the Automatic Level Control (a.l.c.) stage comprising TR14, TR18 and TR23. Transistors TR18 and TR19 form the R.F. amplifying stage and operate in class A, grounded base. The function of TR14 and TR23 is to shunt a proportion of the drive current (thereby reducing the gain of TR18 and TR19) when an input signal is received from one of the a.l.c. detectors.

Note: The a.l.c. stage can be wired in one of two ways depending on the user requirements.

Where a long A.L.C. discharge time constant is required together with an exceptional noise performance at the expense of a marginal degradation, additional components are fitted. Normally however, they are omitted and relevant links substituted.

The comments involved are:-

R48, R49, R50, R51, R28, TR25, TR24, C43, D10.

R18 and R28 are changed from $1M\Omega$ to 100K.

24. The R.F. output from the o.l.c. stage is transformer coupled (via T3) to the next amplifier stage comprising TR17 and TR21 which also operate in a grounded base, push-pull class A condition.
25. T2 couples the signal to the emitters of the final stage of the Low Level Board comprising TR15 and TR16 in parallel, operating push-pull class A, with TR20 and TR22 in parallel.
26. T1 combines the outputs from each half and feeds the signal at approximately 1 to 2W to Pins 2 and 3.

Automatic Level Control (o.l.c.) Detectors

27. The forward d.c. voltage derived from the V.S.W.R. Board is fed to Pin 11. R1 is the 'set forward power' control which determines the threshold level at which the o.l.c. holds the output power under normal conditions. This voltage is amplified by TR1 and is gated via D1 into the o.l.c. switching circuits.
28. The d.c. voltage derived from the reflected power monitor on the V.S.W.R. Board is amplified by TR3 and is combined with a fixed fraction of the forward power via TR2 at the parallel collectors. The output signal, whose level is adjusted by R6 controls the level at which the o.l.c. will respond to a reflected power signal caused by a load mismatch. This output is gated to the following o.l.c. switching circuits via D2, group of switching transistors, and associated capacitors via C3 and C10.
29. The attack time is approximately 200-500 μ seconds and the discharge time is determined by C3 discharging through R18 and changing by approximately 0.1 volt. When TR24 and TR25 are fitted and $R18 = 1M\Omega$ this approximates to 1 second. Normally however, the discharge time without TR24 or TR25 and $R18 = 100K$ the time is approximately 50 milliseconds.

Muting

30. The external muting signal is applied to Pin 12 (OV muted + 12V normal) with 12V applied TR10, TR12 are switched on, thereby supplying +20V to the TR17/TR18 amplifier stage. TR13 is also conducting, supplying a positive bias voltage to the final amplifying stage. Under muted conditions transistors TR10, TR12, TR9 and TR13 are cut off thereby applying muting to both the penultimate and final stages.

31. TR3 and associated diodes, resistors etc, form an input noise immunity circuit. Diodes D11 and D12 provide temperature compensation of TR13 to maintain a stable bias voltage.

High Level Board (PS 315)

Fig. 15

R.F. Signal Path

32. The R.F. input signal from the Low Level Board is connected to Pin 4 which feeds four transformers whose primary windings are connected in parallel via T6, T7, T9 and T10. The secondary winding of T6 and T7 each feed a group of three paralleled resistors and all 6 feed the emitter of TR5. T9 and T10 are similarly connected to drive the emitter of TR6 but are wired in antiphase to T6 and T7. The resultant effect is therefore to drive TR5 and TR6 in push-pull. TR5 and TR6 from the driver stage and operate in grounded base Class B mode. T8 is the driver output push-pull transformer, and it drives T1/T2 and T4/T5 in push-pull, and also T11/T12 and T14/T15 in push-pull. Transformers T4, T5, T11 and T12 are therefore all connected in parallel. T1, T2, T14 and T15 are also paralleled together, both groups operating in push-pull.

33. All eight transformers are 2:1 step-down auto-transformers driving the base of each of the eight P.A. transistors. The eight transistors are connected as four parallel pairs, operating in push-pull, each stage being a grounded emitter class B amplifier. TR1 and TR2 are in parallel giving an output via T3 in push-pull with TR3 and TR4 which are in parallel.

34. Similarly TR7 and TR8 are in parallel, giving an output via T13 in push-pull with TR9 and TR10 which are paralleled.

35. R.F. feedback is applied from the collectors of each paralleled pair via a 470Ω resistor to the collectors of the appropriate driver transistors, to ensure the correct phasing of the feedback voltage.

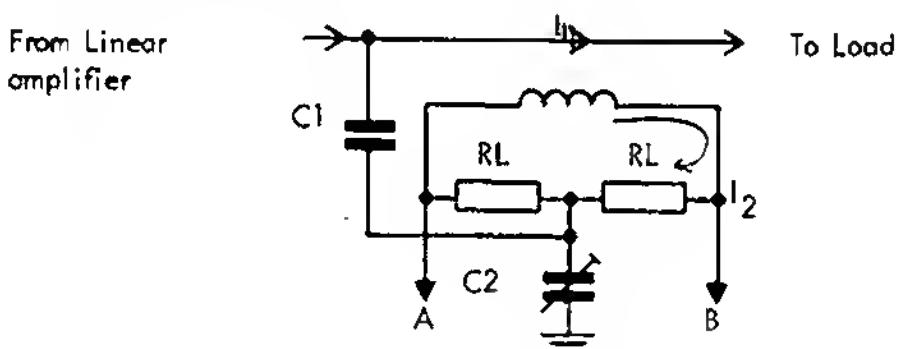
V.S.W.R. Board PS 316

Fig. 17

36. Two R.F. inputs are fed in this V.S.W.R. Board. The first is derived from the reflectometer toroid T2 and is proportional to the RF output line current, and the second is fed from C3 (Fig. 21) which is proportional to the R.F. output line voltage.

Principle of Operation

37. A simplified circuit of the V.S.W.R. Board is shown below to illustrate the principle of operation.



38. The secondary induced voltage in the feeder toroid causes a current to flow I_2 which is equal to $\frac{JWL_2}{2RL+JWL_2}$, where I_1 is the primary current, M is the ~~total~~ mutual inductance, $2RL$ is the total secondary load resistance and L_2 is secondary inductance (of the toroid), W is the angular frequency in radians.

39. If $2RL \ll JW L_2$ at the lowest frequency then $I_2 = \frac{M I_1}{L_2}$, which is independent of frequency. The output voltage developed across each secondary resistor is then $\frac{I_2 RL}{2}$ and they are 180° out of phase.

40. The R.F. voltage divided down by C1 and C2 is applied between the resistor junction point and earth, and adjusted by C2 so that, with the matched line condition, the voltage across C2 is equal in amplitude to the voltage across each resistor. This voltage V_c is also not frequency conscious $V_c = \frac{V_1 C_1}{C_1 + C_2}$ and is in phase with the voltage across one RL and out of phase with the other. The result is that under matched conditions at terminal A the voltage $(V_c + I_2 RL)$ appears (the forward power output) and at terminal B the voltage $(V_c - I_2 RL) = 0$ appears (reflected power output.)

41. Under mismatched conditions such that a short circuit appears on the feeder, then V_c is zero and the forward and reflected outputs are equal. Similarly with an open circuit on the line, the voltages appearing across the two resistors from the toroid are zero, and again the forward and reflected outputs are equal.

42. It can be shown that intermediate mismatched impedances produce some output from the reflected part, but that the forward output remains constant, for a given linear amplifier output power.

43. R1 and R2 from the resistor loads and C3 and C5, in parallel, produce the required capacitive voltage. The outputs are coupled via C2 and C7, then rectified by voltage doubler circuits (D1, D2, C1 and D5, D6, C8) C9 and R5 boost the low frequency power response of the module, by effectively reducing the d.c. level at the forward output at the low frequency end (i.e. below approximately 5MHz). This means that more power is required from the R.F. amplifier module to reach the same a.t.c. threshold voltage.

Protection Board PS 251

Fig. 19

44. The Protection Board has two main functions.

- (1) It monitors the module positive supply voltage and if this exceeds a safe operating level, a pulse is generated to fire a thyristor (mounted on the R.F. Power Module chassis) which in turn blows an associated fuse FS1.
- (2) It also monitors the DC current taken by each group of four transistors and operates the a.c. line if this exceeds a predetermined level.

45. The +30V supply is monitored on Pin 1 and connected via a chain of zener diodes, and a potentiometer R1 to the base of TR1. R1 provides an adjustable reference voltage for the operation of the long-tailed pair comprising TR1 and TR2. The output from TR1 is amplified by TR3 the operating voltage of which is determined by R10 and R13. When transistor TR3 conducts, a voltage is generated which operates the thyristor gate, SCR1, via pin 8.

46. The d.c. current overload inputs are fed to pins 3 and 4, as either or both these levels increase, transistors TR4 and TR5 will start to conduct and cause TR6 and TR1, connected as emitter followers, to conduct and provide a d.c. output to the a.l.c. circuit via pin 5 of the p.c.b. Diode D7 maintains C3 in a charged state so that TR6 will switch on quickly. The Zener diode D5 limits the maximum voltage to approximately 12.5 volts to prevent possible damage to the transistors in the a.l.c. stage on the Lower Level Board.

COMBINING UNIT MS 441

Fig. 23

47. The Combining Unit is a completely passive unit which combines the 125W outputs from the RF Power Modules to produce the 1kW output.

Power Combining

48. The operation of the Combining Unit is best described by considering just one combining operation. Thereafter all subsequent combining sequences are essentially the same, apart from variations of actual impedance and power level. The principle however applies at each stage.

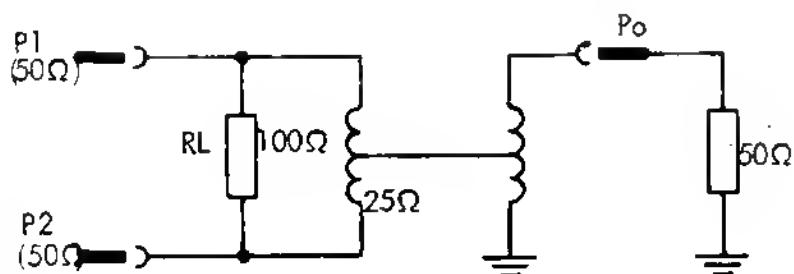


Fig (a)

49. Fig (a) shows a simple combining circuit with a 50Ω input and 50Ω output impedance. The features of this network are as follows:-

If P_1 and P_2 are equal and in phase then $P_o = P_1 + P_2$ and there is zero power dissipated in RL .

If $P_1 = 0$ the $P_o = \frac{P_2}{2}$

i.e. -6db reduction on original P_o with both inputs preset. In this case $\frac{P_2}{2}$ is also dissipated in $4.RL$. If P_1 and P_2 are 180° out of phase, zero power appears at the output and $P_1 + P_2$ is dissipated in RL .

50. Although for maximum power output P_1 and P_2 should ideally be matched exactly in amplitude and phase fairly large differences can be tolerated within the extremes quoted above before a significant reduction in output power occurs. For example a 10% difference in amplitude results in a power output reduction of approximately 0.2% while a phase difference of 10% only results in a power output reduction of 0.75% of the total input Power $P_1 + P_2$.

Isolation

51. The second basic property of the combining network is that it provides isolation between the two inputs. This means that any impedance change at either input does not affect the input impedance presented to the other generator.

52. How this isolation is achieved is illustrated by considering the equivalent circuit of the two extremes i.e. open circuit and short circuit as well as the normal 50Ω condition.

53. Fig. (b) shows the 50Ω input case. The impedance at the hybrid transformer output is 25Ω for the two inputs to be 50Ω . This explains the necessity of 2:1 impedance transformation to achieve an output impedance of 50Ω after the hybrid transformer.

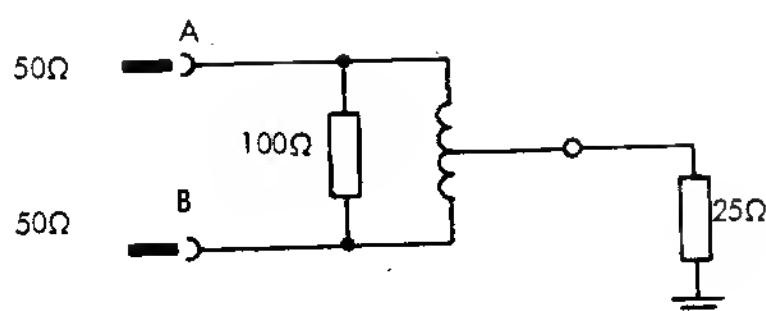


Fig (b)

54. Fig. (c) shows the equivalent circuit for a short circuit at input B. The 50Ω impedance at the hybrid output is transformed up to 100Ω at input A, in parallel with RL giving a resultant input impedance of 50Ω (i.e. as normal).

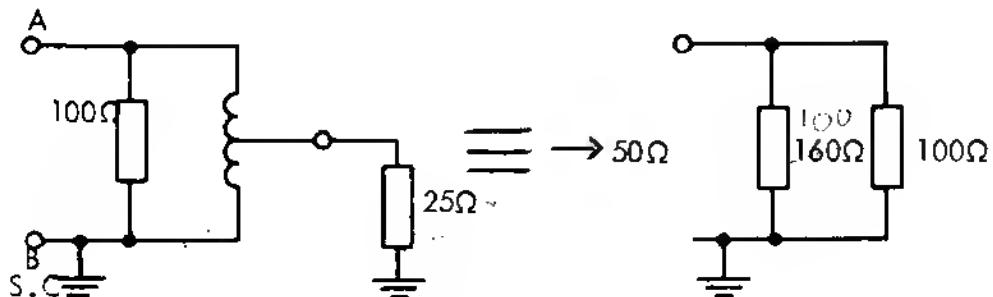


Fig. (c)

55. Fig. (d) shows the equivalent circuit for an open circuit at input B. The 100Ω impedance of RL is transformed to 25Ω in series with the existing 25Ω load impedance giving a resultant impedance of 50Ω at input A (i.e. as normal). It can be shown that input A will always be 50Ω for miscellaneous impedances appearing at input B.

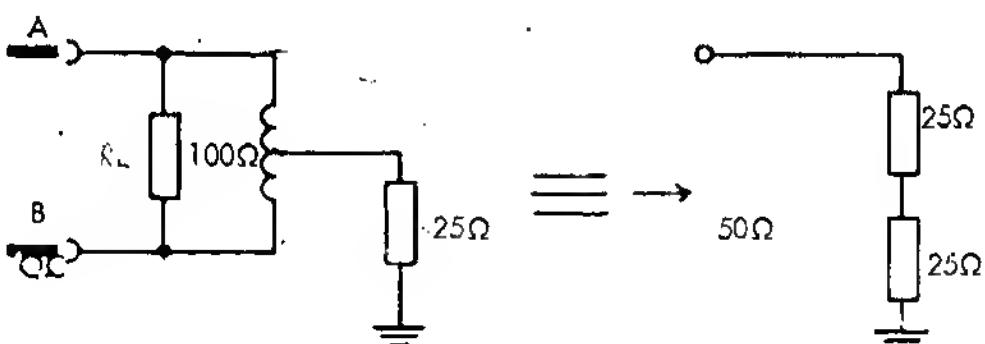


Fig. (d)

Design Features

56. In order to meet the theoretical performance outlined in the proceeding paragraphs it is necessary to provide balancing coils in series with each ballast resistor to ensure optimum isolation and input impedance matching over the full frequency range. This offsets the effects of transformer leakage inductance and circuit stray capacities which would otherwise cause an inferior performance.

WARNING

THE SETTING OF THESE ADJUSTABLE INDUCTORS IS CRITICAL AND THEY ARE ACCURATELY SET UP BEFORE DESPATCH FROM THE FACTORY. ANY FURTHER ADJUSTMENT SHOULD NOT BE NECESSARY BUT IF THIS IS CARRIED OUT IT SHOULD ONLY BE DONE UNDER CONTROLLED CONDITIONS WITH APPROPRIATE TEST GEAR - SEE CHAPTER

Power Dissipation

57. As described previously if power from one or more modules is lost then an unbalanced situation is created in the combining unit which results in power dissipation within the combining unit, as well as a reduction of output power. Fig 5.1 shows the approximate output power against numbers of inoperative modules - the white sections show the power dissipated internally and the shaded columns indicate the actual output power.

Note: The conditions given in Fig. 5.1 are 'worst case'. With four modules operational the linear amplifier can be 'patched' to give 500W output (refer to Chap. 1 para. 17)

58. The combining unit is rated to withstand the maximum dissipated power (i.e. 250W) continuously. A warning signal is however signalled out showing that power is being lost in the combining unit. This is sensed by a current transformer in each ballast resistor line. This R.F. unbalanced signal is rectified and fed to the Overload Unit MS443 where it is available to indicate that the TA 1810 is operating on reduced power. This reduced power lamp is located in the MA 1720 exciter. It is only a warning indication and does not trip off the amplifier, since there is no risk of damage whilst continuing to operate in this condition.

59. The eight R.F. inputs from the R.F. modules are fed into hybrid transformers in pairs. Inputs 1 and 2 are fed to opposite ends of AT3 and AT5 in parallel. Inputs 3 and 4 are connected to opposite ends of AT4 and AT6 in parallel - similarly for inputs 5, 6, 7 and 8.

60. Also connected in parallel with AT3 and AT5 are ballast resistor R3 in series with a current monitoring transformer AT1 and an inductor L1. L1 operates in conjunction with C1 and is adjusted for maximum isolation and optimum input impedance matching. The output of AT1 is detected and fed to PL1 Pins 8/9 and then on the Overload Unit, to provide an R.F. unbalance signal.

61. Remaining input hybrids are identical to inputs 1 and 2. The outputs from AT3, AT5 and AT4/AT6 on Board A are then fed to the next hybrid transformer stage T1. R5 and R6 are connected in parallel across the primary of T forming the ballast load in series with L3, which together with C5 and C7 optimises the isolation.

62. The output from Board B feeding T2 is identical to that from Board A.

63. The output from T1 appears at an impedance of 12.5Ω and this is 'stepped up' to 50Ω by T3. This is then fed to SK9 via T5 current monitoring transformer. SK9 is then normally connected to L2 which feeds one side of the 1KW hybrid transformer T7 and the other side is fed from the other 500W output appearing at SK10. R3, R4, R5 and R6 form the ballast load for T7, and have a total rating of 250W. The output of T7 is at 25Ω impedance, and is transformed to 50Ω by T8. C9 is included to improve the isolation of the two 500W inputs. T9 is a current transformer for output monitoring.

Automatic Level Control and Protection

64. The overall Automatic Level Control (a.l.c.) protection aspect of the TA 1810 Linear Amplifier is an important and basic feature of the design, both for normal operation and for protection under abnormal conditions.

65. Protection of the transistorized R.F. Power Modules is vital for the overall reliability of the equipment and in many instances the protection circuiting operates via the a.l.c. stages of the module so that the two are closely interdependent.

66. The details of the actual a.l.c. stage have been described in paras. 27 to 29. It is this stage which is controlled under various overload conditions as well as for normal operation.

67. The following inputs are connected to the a.l.c. and an exceeding the pre-set threshold level, will determine the operating gain and hence the output level of the R.F. Power Module.

- (1) Forward Power - normal operation
- (2) Reflected Power - operates to a.l.c. if mismatch at the output is less than approximately 2.1 V.S.W.R.

- (3) Transistor Collector
- R.F. Voltage (Swingometer) - Operates the a.l.c. if the voltages exceeds a pre-determined level (normally approximately 25V peak)
- (4) DC current - Operates the o.l.c. if the mean d.c. current, when driven, exceeds 15 Amps.

68. The levels at which the forward and reflected power take over control of the A.L.C. are adjustable but should only be set up in accordance with the instructions laid down in Chapter 9. In the case of the collector R.F. voltage and D.C. current detectors these are pre-determined by the design values of components and cannot be varied.

The attack and decay times of the respective inputs are listed in para. 29.

69. In addition to the previously mentioned a.l.c. protection circuits, additional protection is included as follows:-

- (1) A thermostat to detect overheating of each module.
- (2) A 'latching' trip circuit for each Stabiliser Unit.
- (3) A high rupturing capacity fuse for each module for protection against a stabiliser short circuit.
- (4) A magnetic circuit-breaker for AC supply input overload protection to each power unit.

70. Together these overload circuits provide an extremely high degree of overall protection.

POWER SUPPLIES

Power Supplies Unit Type MS 64

Fig. 25

71. Each Power Supply Unit Type MS 64 is a self contained d.c. power supply providing a smoothed unregulated d.c. outputs from a single phase a.c. supply.

72. Two outputs are provided:-

- (1) +35V at 30 amps
- (2) +40V at 100 milliamps.

Each incorporates a bridge rectifier, from two separate transformer windings. The +35V rail has a choke input filter, while the +40V supply employs a capacitor input filter.

72. (cont'd)

Under no load conditions, however, the +35V supply behaves like a capacitor input filter and the no load voltage rises to approximately 60V. The associated units are adequately rated to withstand this.

73. A plug-in mains selector is provided on each MS 64, to provide simple adjustment on installation.

Stabiliser Unit Type MM440

Fig. 27

74. The stabiliser Unit Type MM 440 provides a stabilised +30V and +20V supply to the R.F. Amplifier Type MM 320. It is fed from the main power supply unit Type MS 64 which provides a smoothed nominal 35V, at full load, to each stabiliser.

Note: In the following circuit description the component prefix codes detailed in Chapter 1 are used.

75. In addition the Stabiliser unit provides current metering facilities for the +30V and +20V supply rails to each R.F. Amplifier Assembly. A fast acting current overload trip circuit is also included. The latter is reset by switching the R.F. Amplifier Module off and on again. All power dissipating components e.g. power transistors and resistors are mounted directly on the finned casting. The low level circuitry is included on a printed circuit board, PS 313.

Output Ratings

76. The maximum current ratings of the two supply lines are:-

- (1) +30V at 15 amps.
- (2) -20V at 2 amps.

77. The normal 36V DC input to the Stabiliser Unit from the MS 64 power units, is connected to Pins 12, 13, 14, 15 and 16 in parallel (positive) and pins 4, 5, 6, 7 and 8 in parallel (- OV) Pin 3 is a separate earth.

78. A second d.c. input at +40V is required to feed 4TR2 and 4TR5. This is also fed from the MS 64 power units. The maximum current consumption, however, is only 50mA. The +30V and +20V stabilised outputs appear on TS Pins 2 and 3 respectively.

79. The stabiliser itself comprises three separate circuits as follows:-

- (1) +30V Stabiliser
- (2) +20V Stabiliser and
- (3) DC Overload/Trip Circuit.

+30V Stabilizer

80. The main d.c. input is fed to TR1 and TR4 connected in parallel. These are the main series stabilising transistors. They are controlled by a feedback system comprising 4TR5, 4TR2 and 4TR3. Transistor 4TR5 is the comparator stage while 4TR2 and 4TR3 provide current amplification for the feedback loop. The emitter of 4TR5 is held at 5.6V by 4AD3 while the base voltage is derived from the stabilised +30V rail via an adjustable resistor R10. This controls determines the setting of the +30V output level. The overall stabiliser loop functions as follows:-

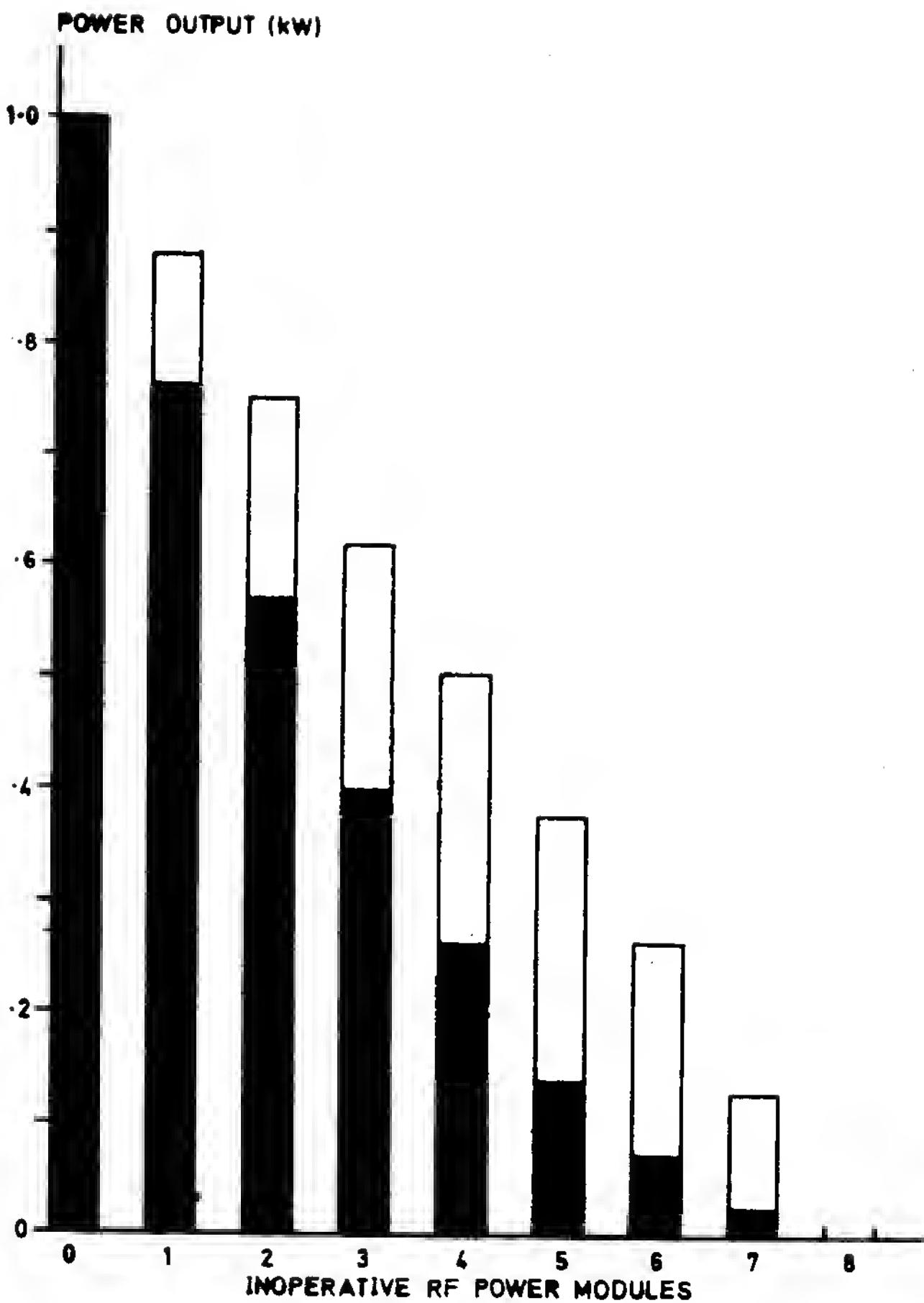
81. As the volts tend to rise, due to a reduction of load current, TR5 base voltage will also rise, causing 4TR5 to conduct more, which in turn causes 4TR2, 4TR3 and TR1 and 4TR4 to conduct less. This gives a greater voltage drop across 4TR1 and 4TR4, thereby reducing the output voltage and opposing the initial change of output level. The circuit is therefore self compensating, and with the high loop gain involved relatively large input voltage variations have no effect on the output voltage.

+20V Stabiliser

82. This follows the +30V stabiliser and has 4TR7 as the main series stabiliser, with 4TR6 as an amplifier and 4TR4 as the reference detector stage. The output level is set by R16. In principle it functions exactly as the +30V stabiliser.

D.C. Trip Circuit

83. As the d.c. load current increases the voltage drop across 4AR1 increases. This increases the voltage appearing across the base of 4ATR1 - which is adjustable via 4AR3. Under normal conditions this voltage is insufficient to cause 4ATR1 to conduct so that TR2 is also non-conductive. The collector voltage of 4ATR2 is high and therefore isolated from the main +30V stabilising feedback loop i.e. base of 4TR2, by 4AD2.



Ratio: Approximate Output/
Inoperative Modules

WOH3037

Fig. 5-1

CHAPTER 6

ROUTINE MAINTENANCE, DISMANTLING AND REASSEMBLY

ROUTINE MAINTENANCE

1. Routine maintenance requirements on the TA.1810 amplifier are minimal, as only the following items need be checked at regular intervals.

Air Filter

2. This should be washed at appropriate intervals in water with a detergent.

NOTE: Ensure filter is completely dried before replacing in cabinet.

Contactor Contacts

3. It is recommended that the contacts on the main switching contactor be examined every six months, and replaced if significant deterioration is observed.

NOTE: The bearings of blowers are 'sealed for life', therefore no lubrication is required.

DISMANTLING AND REASSEMBLY

4. Modulator construction is used throughout, and access to all sub-units and cabinet connectors is via the front of the cabinet.

Power Supply Unit type MS 64

5. The Power Supply Units Type MS 64 are mounted in two banks (each comprising two MS 64 Units) at the bottom left and right of the TA 1810 cabinet.

CAUTION: When the cabinet is not fixed to the floor only one bank of power supplies should be withdrawn at any one time to avoid the danger of the cabinet toppling.

Removal

- (1) Undo the 4 quick release screws on either side of the Power Supply Unit front panel and remove the front panel.
- (2) Switch off the circuit breaker appropriate to the power supply unit to be removed.
- (3) Remove the Pozidriv screw securing the angle bracket, mounted on the front edge of the appropriate bank of power supplies, to the front edge of the cabinet; pull the pair of power supplies forward to their fullest extent.
- (4) Remove the mains shroud to the appropriate power supply.
CAUTION: If one half of the TA 1810 Linear Amplifier is operating, use a meter to check that mains is not present.
- (5) Disconnect the mains cable and remove the three Pozidriv screws securing the bottom of the power supply to the mounting panel.

- (6) Slacken off but do not remove the 3 Pozidriv screws securing the top of the power supply to the mounting panel.
- (7) Remove the power supply from the mounting panel.

Replacement

7. Replacement of a power supply is effected by reversing the procedure described in para. 6 (1) to 6 (7).

Splitter Unit, Distribution Amplifiers and Overload Unit

8. The Splitter Unit, Distribution Amplifiers and Overload Unit are mounted on a hinged plate which is located above the power supplies. The cover to each unit is secured by four slotted screws whilst the units are secured to the hinged panel by Pozidriv screws.

Circuit Breakers

9. The circuit breaker assemblies are mounted on either side of the overload unit but fixed to the cabinet upright. Access to these assemblies, which contain auxiliary, starting relays and surge resistors, is via screwed metal covers. These are provided with warning plates since mains voltages exist on the circuit breaker terminals underneath the cover plates. When replacing a circuit breaker ensure that the cable grommet is properly positioned and that the cables are not trapped.

Main Switching Contactor

10. The main switching contactor is located on the back of the hinged mounting plate located above the power supplies.

Removal

- (1) Undo the fixings on the left hand side of the hinged mounting plate.
- (2) Disconnect the coaxial output sockets (8SK1 to 8SK4) from each Distribution Amplifier and hinge the plate forward.
- (3) Isolate the cabinet from the mains supply and remove the contactor cover for access to the cover and the Remote/On relay.

Replacement

12. To replace the main contactor reverse the procedure detailed in 11 (1) to 11 (3).

Air Blowers

13. Two air blowers are located immediately above the power supplies, the lower bank of RF Power Modules must be removed to give access to the fixings on the blower plate.

Removal

- (1) Isolate the cabinet from the mains supply.
- (2) Remove the power supplies panel.
- (3) Hinge forward the mounting plate as described in para. 11 (1) and 11 (2).
- (4) Remove the lower four RF Power Modules.
- (5) Slide the power supplies forward to their fullest extent.

CAUTION: When the cabinet is not fixed to the floor only one bank of power supplies should be withdrawn at any one time to avoid the danger of toppling the cabinet.
- (6) Disconnect the cabinet terminals on the blower .
- (7) Use a 3/8" box spanner through the access holes, provided by removing the lower 4 RF Power Modules, to undo the 4 blower plate captive fixings.
- (8) Lower the blower gently to the floor and remove from the cabinet.

Replacement

15. (1) Replacement of on air blower is effected by reversing the procedures described in 14 (1) to 14 (8).

(2) Before attempting to tighten the 4 blower plate captive fixings, locate the blower in position and ensure that fan outlet is correctly located within the air duct.

RF Power Modules

16. The RF Power Modules are removed by undoing the 2 quick release screws and sliding the module forward from the cabinet. When replacing a module ensure that is properly located in the guide channel.

Meter Panel

17. The Meter Panel is located above the RF Power Modules and houses two meters and the V.S.W.R. Warning p.c.b.

Removal

18. (1) Remove Meter Panel plug (11PL1).

(2) Remove the 4 screws securing the hinges and remove the Meter Panel from the cabinet.

(3) To obtain access to the meters and the V.S.W.R. Warning p.c.b. remove the 5 fixing screws (3 front and 2 rear) and remove the cover.

Replace

19. To replace the Meter Panel reverse the procedures detailed in 18 (1) to 18 (3).

Combining Unit

20. The unit or units located above the Combining Unit must be removed to give reasonable access to the rear fixings.

Removal

21. (1) Fully lower the Meter Panel by releasing the catch on the left hand side of the cabinet.

- (2) Disconnect the 4 RF connectors on the right hand side of the unit.
- (3) Disconnect the 4 RF connectors and the 9-way Connon D connector on the left hand side of the unit.
- (4) Disconnect the RF connector from the front of the unit.
- (5) Remove the fixing screws from the rear edge of the unit.
- (6) Slacken off the captive fixings on the lower flanges (2 left hand side and 2 right hand side).
- (7) Lift one side of the unit and ease it out from the cabinet through the gap immediately above, taking care not to foul cables.

Replacement

22. Replacement of the Combining Unit is effected by reversing the procedures detailed in 21 (1) to 21 (7).

RF Power Module MM 420

23. To separate the Stabilizer Module from the RF Power Module proceed as follows:

- (1) Slacken the 4 fixing screws on tag strip TS1 and remove the fanning strip.
- (2) Remove the fixing nuts and washers on both RF connectors (SPL1 and SPL2) on the rear panel noting carefully the order in which the washers are removed.
- (3) Remove both Pozidriv screws connecting the top plate of the MM 440 Module to MM 320 Module.
- (4) Slacken off the top and bottom nuts and bolts connecting the mating edges of the heat sink.
- (5) Remove the Stabilizer Module by pulling it in the direction of the heat sink.

High Level Board

4. To obtain access to the High Level Board proceed as follows:

- (1) Place the complete module assembly on a bench with the front panel of the module to the right and the heat sink on the bench.
- (2) Remove the fixing nut on plug SPL2 on the rear panel noting carefully the order in which the washers are removed.
- (3) Remove both Pozidriv screws fixing the Low Level plate to the pillar nuts.
- (4) Remove 2 nuts and bolts connecting the Low Level plate to the front panel.
- (5) The Low Level plate may now be hinged away to give access to the High Level Board.

CAUTION: If it is required to operate the module in this condition care must be taken to ensure that the Low Level plate does not short live points.

Method of Changing a P.A. Transistor

- (1) Disconnect the Low Level Board sub assembly (including its mounting plate) so that it can be hinged up and over to gain access to the High Level Board (refer to para. 24). Unsolder the pins of the relevant transistor, and then place the module in its normal upright position with access to both sides of the transistor.
- (2) Undo the nuts on the stud end with a box spanner. To do this and prevent rotation of the transistor it will be necessary to hold a broad screw driver blade against one side of the hexagonal shaped transistor body through the appropriate hole on the High Level Board.
- (3) When refitting a new transistor use new insulating washers (Racol Part No.) and cover both sides of the washer with 'Thermaflow' thermal paste Type A30/J (Jermyn Industries) before assembly. Reverse the procedure detailed in paras. and for re-assembly.

Note: It is important that this or other high conductivity paste is used in preference to silicone grease to ensure adequate heat sinking on transistor.

Access to Stabilizer Heat Sink

26. Remove the Stabilizer (refer to para. 23) or hinge back the Low Level plate (refer to para. 24).
Undo 2 screws fixing the top plate to the rear plate on the stabilizer.
Hinge back the top plate to obtain access to the components mounted on the stabilizer heat sink.

Note: The cover of the V.S.W.R. Board must always be in position when the module is operating.

CHAPTER 7

FAULT LOCATION & ALIGNMENT PROCEDURE

INTRODUCTION

1. Any fault on the TA.1810 can be very quickly located to a particular sub-unit using the front panel facilities provided.
2. Each RF module has a green lamp indicating that the DC supply is present, and a clear lamp which is illuminated when the module is emitting. Metering is included to show the supply current and voltage levels, and RF monitoring points are included at each stage to provide check facilities, using an oscilloscope or spectrum amplifier. The RF input and RF output powers (both forward and reflected) are also metered.

FAULT LOCATION PROCEDURE

3. If a malfunction occurs, the following should be checked:-
 - (i) All module green lights are illuminated.
 - (ii) All module yellow lights are illuminated when the amplifier is driven.
 - (iii) Individual module currents and voltages
 - (iv) RF input power.
 - (v) RF output power (forward and reflected)

The sequence of checks outlined in Tables 1 and 2 will, in conjunction with the previous checks, locate the fault quickly to the power supplies stabilizer unit, RF modules, combining unit, distribution amplifiers or splitter unit.

TABLE 1

LOSS OF MODULE 'POWER ON'LIGHTS

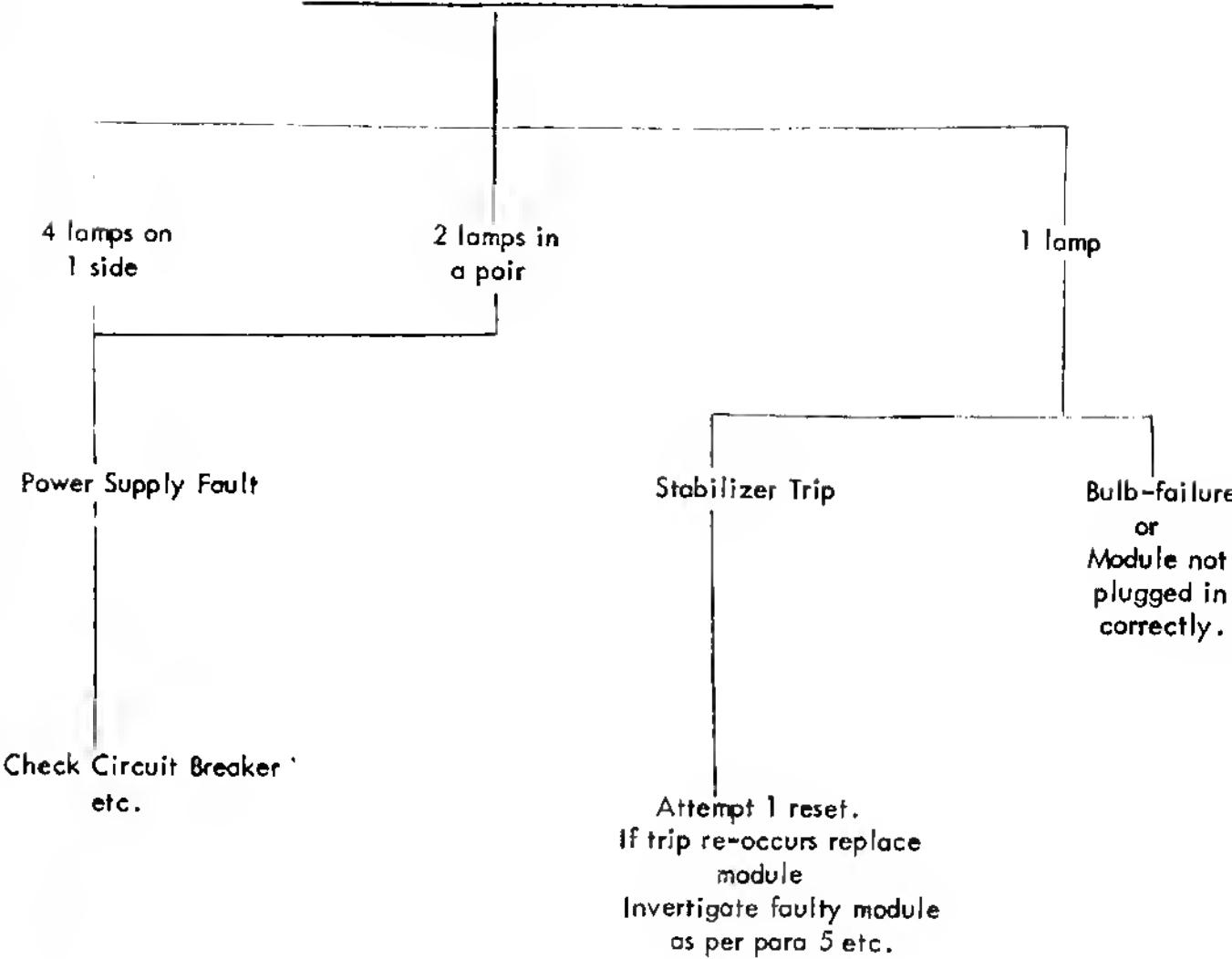
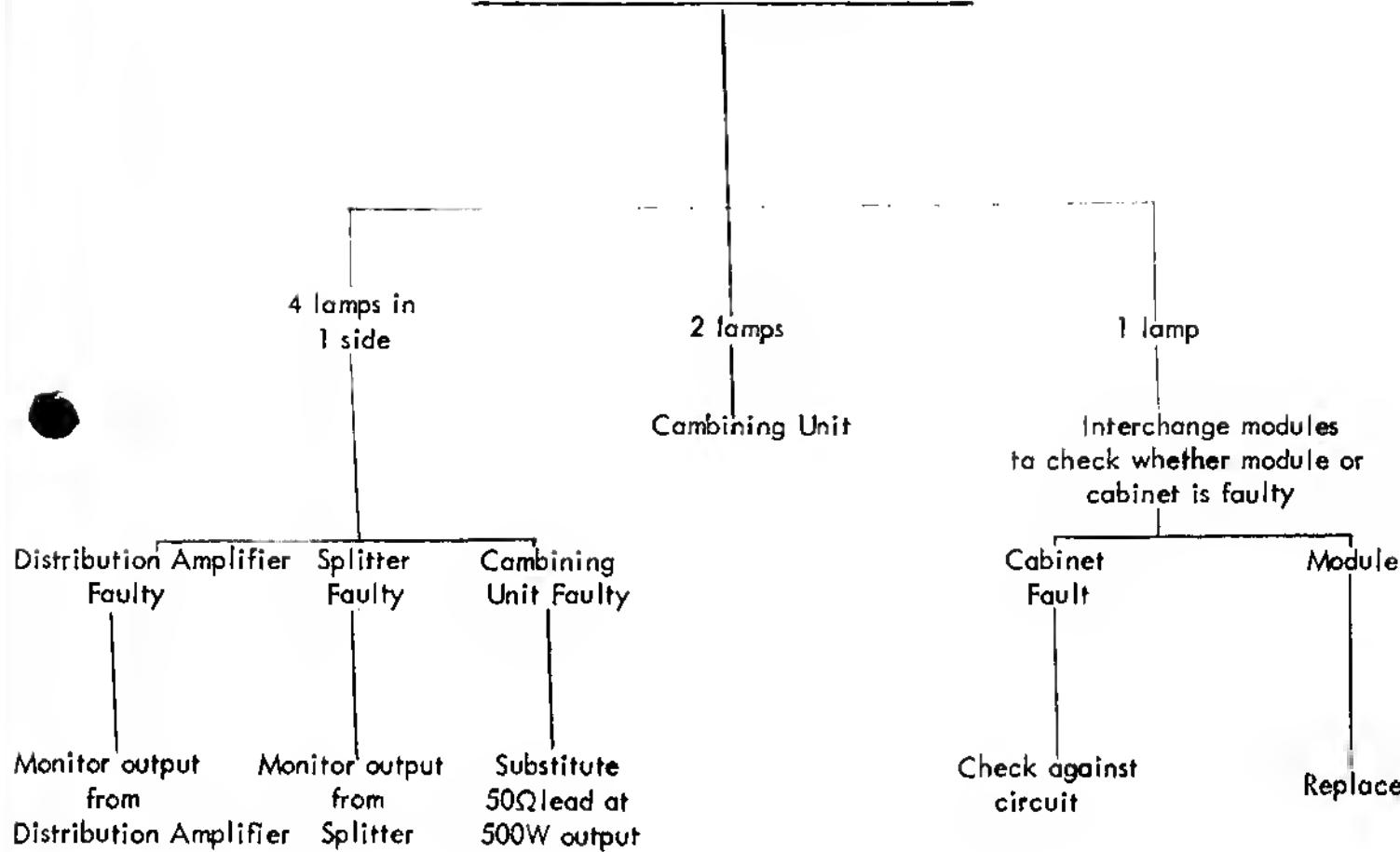


TABLE 2
LOSS OF MODULE RF OUTPUT LIGHT



Sub-Unit Fault Location

4. Fault location on sub-units is a fairly simple process; in most cases it is merely a matter of checking against the circuit diagram. The exception is the RF Amplifier Module Type MM.420, and procedures for detailed circuit checking are described below.

FAULT LOCATION - RF MODULE TYPE MM.420

5. When a faulty module has been identified it is recommended that it be replaced and subsequent fault location carried out away from the transmitter using external supplies, dummy load, power meter etc.
6. DC Supply + 36V at 15 amps
 - (i) DC Supply + 35V at 15 amps
 - (ii) DC Supply + 40V at 100 Milliamps
 - (iii) RF Power Meter - Bird ThruLine Model 43 with 250W head.
 - (iv) 50Ω 250W Dummy Load - Bird Model 8141
 - (v) Valve Voltmeter Marconi TF1041C
 - (vi) Module DC and RF Connectors
 - (vii) Module extension leads

RF Module Checks - Without RF Drive

7. Switch on the external supplies to the module. Monitor DC voltage outputs from the stabilizer on TS1. Switch on MM.420 front panel switch. If the Stabilizer unit trips (i.e. output volts disappear). Attempt one reset operation. If the trip operates a second time, switch off completely and measure the supply line impedance to earth with an Avameter (less than 10Ω indicates an abnormal condition requiring further investigation). If the impedances appear satisfactory, then the setting of the Stabilizer trip level should be checked (see paragraph 17).

RF Module Checks - With RF Drive

8. Check that the +30V supply current (to the High Level Board) is approximately 8A to 12A dependent on the drive frequency. Even if the current measured appears to be correct it is advisable to check all RF power transistors by measuring each emitter voltage (from each transistor stud to earth)

NOTE: Ensure transistor stud is not earthed or the transistor may be destroyed. The eight output transistors should be equal within 0.1V. Typical voltages are approximately 0.5V but are slightly dependent on the drive level applied.

9. If zero voltage or a significantly low voltage exists, the appropriate transistor should be changed using the procedure described in Chap. para. .

10. If a discrepancy of more than 0.1V exists, then checks on RF drive levels on the transistor must be made, following logically the RF signal path as given in the circuit diagram. Typical causes could be bias voltage errors or circuit dry joints.

11. Measurements of RF gain on both the Low Level Board and overall module are sometimes necessary to locate a low gain stage. When checked at 10MHz below the A.L.C. operating level the input signal for a 100W output should be within 300mV and 500mV injected at the module input socket.

12. With the Low Level Board terminated in (a 50Ω 2W non-inductive resistor, and isolated from the High Level Board, its output should be 2W for an input signal between 10mW + 1.0dB at 2MHz, injected at the module input socket. On the band the input variations should be +4dB - 1.0dB relative to +2.0MHz.

13. When the low gain stage is located, detailed DC measurements on individual components will enable easy identification of the fault .

ALIGNMENT PROCEDURES

Adjustments to R.F. Module MM.420

14. Following repair work and/or component replacement, it is necessary to carry out the complete adjustment procedure (paras 16 to 22) on the RF Module, to ensure that all operating and protection levels are correct. Unless the procedure is correctly carried out the RF module may not be performing to its specification and may suffer further malfunction if not adequately protected due to incorrect settings. In addition it may periodically be necessary to carry out a routine check of the module performance. In such cases, the following procedure should be carried out.

15. For the purpose of setting-up and re-aligning, the module may be operated completely separately from the main amplifier using an independent DC supply, 50Ω board and drive source. Alternatively the MM.420 can be operated out of the transmitter but using extension leads to connect to the TA.1810 supplies. If the second procedure is used, the TA.1810 should be operated as two separate 500w units, and the three modules associated with the one under test should be switched off. The following items of test equipment are required:-

(i) Set of Extension Leads (RF & DC).....

(ii) Variable resistor load (3Ω 20amp. rating)

(iii) RF Power Meter e.g. Bird. ThruLine Model 43 with 500w head.

Note Since the module is operated outside the cabinet it will not be forced air cooled, therefore it is recommended that it is not operated for more than 20 mins at full power. If, however, this time is greatly exceeded the module thermostat will operate to avoid overheating.

Setting-up the Stabilizer Output Volts

16. Check the nominal 30V supply at tags 2 and 1 T.S.1. Adjust 4AR10 on the Stabilizer Unit to set this voltage to 30.5 volts. Check the nominal 20V supply at tags 3 and 1 TS1. Adjust 4AR16 on the Stabilizer unit to set this voltage to 20 volts.

Setting-up the Stabilizer Trip Levels

17. An external variable load resistor should be connected between tag 2 and tag 1 on TS1. The module should be unplugged from the supply. The load resistor should then be adjusted to give 18-18.5 amps, as indicated on the front panel meter switched to the appropriate module. After setting 4AR3 fully anti-clockwise, the module (with its front panel switch set to Off) should be reconnected. Turn 4AR3 clockwise slowly until the stabilizer trip circuit operates. Adjust the load resistor to maximum and re-set the trip by switching the supply OFF and then ON. Slowly increase the load current by varying the load resistor, and check that the trip operates at 18 to 18.5 amps. If not, repeat the above procedure by adjusting 4AR3 until correct operation is achieved.

Setting-up Module Over Voltage - Low Level Trip

18. Monitor the nominal 30V supply between Tags 2 and 1 on TS1, and adjust 4AR10 to increase the output voltage. Check that the over voltage trip operates between 32.5 and 33.5 volts. This adjustment should be carried out with the module undriven. In no circumstances should the output voltage be increased above 34 volts. If the trip does not operate at the specified levels, slowly adjust SCR1 on the protection board until it does so. Re set the supply voltage to 30.5 volts by adjustment of 4AR10.

Setting-up Module V.S.W.R. Unit

19. Connect a low level R.F. input signal (approximately 2mW measured at the module input) at a frequency of 10MHz. Connect an Avometer with its positive between pin 5A10 (tve) and earth. Adjust the trimmer 5DC3 for minimum indicated voltage on the Avometer, which should be between 500 and 700 m.V.

Setting-up Reflected Power Protection Level

20. Set 5AR6 on the module low level board fully clockwise. With an RF input signal of 10MHz at a level of 2mW connected to the module, unplug the module RF output connector. Check that the DC current, as measured on the meter panel, does not exceed 3 amps. If this value is exceeded a fault condition exists and must be corrected before proceeding further. Increase the drive level to approximately 10mW and adjust 5AR1 to give approximately 50W output power on the Thruline Wattmeter. Apply a short circuit at the RF output connector and adjust 5AR6 so that the DC current level is 6.5 amps. Remove the short-circuit and re-connect the RF output load.

21. Set the drive signal to 18MHz at a level of 10mW. Set the module output power to 135 watts (into a 50Ω dummy load) by adjusting 5AR1 on the module Low Level Board. Check that as the frequency is raised from 1.6 to 30MHz (at 10mW input) the output does not exceed 150W or drop below 120W.

SETTING-UP AND ADJUSTMENTS OF V.S.W.R. UNIT MS447

22. This unit should be set-up with the TA.1810 operating into a 50Ω dummy load at full power. With the reflected power meter selected, observe the indicator. If this exceeds 25 watts, (and the load is genuinely 50Ω) then the V.S.W.R. unit is unbalanced. Adjust C3 for a null at an operating frequency of 10MHz. If the null cannot be reduced to 25W or below switch off and remove the unit. Carry out detailed d.c measurements against the circuit diagram to check diodes, resistors etc.

Setting-up and Adjustments on Combining Unit MS.441

23. As described in Chapter 5, all adjustments to the Combining Unit are carefully set up in the factory prior to dispatch; re-alignment is not normally necessary. Only in the very rare occurrence of a transformer requiring to be replaced should this unit need to be re-set up. The procedure requires the use of specialized equipment such as a Rhode and Schwarz Polyscop. Using such an equipment adjustment of the relevant coils should be made to achieve a compromise of matched input impedance and isolation over the frequency range.